Space Weather Technical Forecast

Issued on Wednesday, 04 September 2024 at 12:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Ongoing but waning chance of G1/Minor Geomagnetic Storm interval Day 1 (04 Sep). M-flares expected, slight chance of X-flares. Chance of S1/Minor Radiation Storms through the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity was Moderate in the past 24hrs, with several M-class flares. The strongest one was an impulsive M3.3 peaking at 03/1602 UTC from AR3813 in the southeast quadrant. There are currently twelve sunspot regions on the visible disc, five of which are unnumbered. AR3807 (Fki/Beta-Gamma-Delta), is approaching the southwest limb but remains the largest region by area and maintains a delta spot. AR3806 (Eai/Beta-Gamma-Delta) near south centre disc is another complex and relatively large region and continues to display at least one delta configuration. AR3813 (Ekc/Beta-Gamma) close to the far southeast appears to be a large and complex region, but foreshortening still prevents a confident assessment. A further region close to the southeast limb continues to emerge and may be magnetically connected to AR3813. All other regions are relatively simple and stable at present.

A weak CME was observed off the northeast limb around 03/2030 UTC and is not estimated nor modelled by Enlil to be Earth-directed. No other Earth directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind parameters as measured by DSCOVR at L1 were indicative of a return to a slow regime, easing from 390 km/s to 320 km/s. The solar winds sharply increased from 330 km/s to slightly elevated levels of around 410 km/s at 04/0937 UTC, which is likely to be the arrival of a shock from the CME that left the Sun on 01 Sep. Density was below average initially and gradually increased from around 04/0100 UTC becoming above average around 04/0500 UTC and reaching a peak of 37ppcc at 04/1002 UTC. The Interplanetary Magnetic Field, Bt, was mostly moderate, increasing to strong around 04/0940 UTC with a peak of 27nT at 04/1039 UTC. The north-south component, Bz, remained mostly weak and steady around 7nT, fluctuating more strongly after 04/0800 UTC and ranging between -4nT and +22 nT. Phi angle was mainly negative (towards the Sun), switching for a time to positive (away from the Sn) 04/0208-1001 UTC. Resulting geomagnetic activity was Quiet (Kp 1-2) but with an Active (Kp 4) interval 0900-1200 UTC following the glancing blow from the aforementioned CME shock.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 has remained at elevated levels in response to the M5.5 flare on 01 Sep but remains below the S1 level, peaking at 6.4 pfu at 03/1355 UTC. High energy electron flux (greater than 2MeV) observed at GOES16 was at background to moderate levels with a diurnal peak of 550pfu at 03/1715 UTC. The 24-hour fluence has been on a rising trend over the past 24 hours but remains well below the Active threshold.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected with a slight chance of isolated X-flares. The main flare risk is currently from AR3806, AR3807 and AR3813. AR3807 is expected to rotate beyond the western limb during Day 3 (06 Sep). New or returning regions may rotate onto the disc

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during the period, most probably Day 4 (07 Sep).

Solar Wind / Geomagnetic Activity: The recent uptick in geomagnetic activity and solar wind speeds has been attributed to glancing effects from a large CME off the southeast limb on 01 Sep, the bulk of which is expected to pass well behind Earth's orbit. There is a waning chance of a G1/Minor Geomagnetic storm interval during Day 1 (04 Sep). Two coronal holes are currently present on the western hemisphere, CH67/- and CH/65/+. The HSS associated with the positive coronal hole may enhance wind speeds to 450-500km/s on Day 4 (07 Sep).
Mainly Quiet to Unsettled (Kp 1-3) activity is expected with a chance of Active (Kp 4) intervals on Day 4 and a slight but waning chance of G1/Minor Storm intervals (Kp 5) on Day 1 following the recent CME shock arrival.

Energetic Particles / Solar Radiation: High energy proton flux is above background levels, but below the S1/Minor Radiation Storm threshold. There is a chance of exceeding S1 in the coming days. High energy electron flux is expected to remain at background to moderate levels, perhaps rising late in the period following any CME effects. There is a slight chance of fluence reaching the Active threshold by the end of the period.

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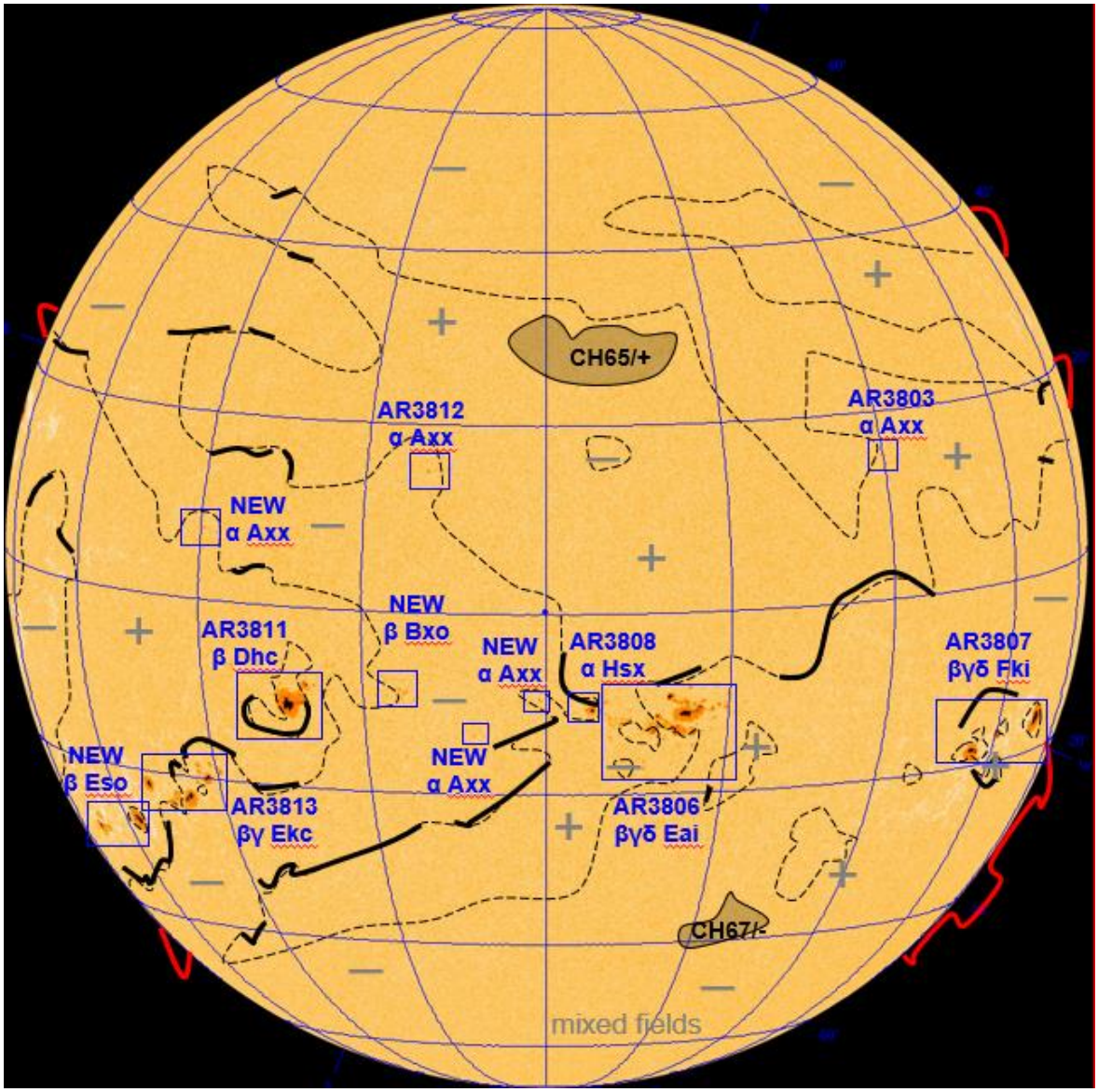
Figure 1. Solar Analysis Valid 04/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A large eruption off the southeast limb through the UTC afternoon of 01 Sep was analysed with Enlil projecting that the bulk of the CME will pass well behind Earth's orbit. However, LASCO C3 imagery did show a faint asymmetric halo, likely shock from the eruption. Solar wind parameters, as measured by DSCOVR at L1, suggested the arrival of the shock at around 04/0940 UTC with a sharp uptick in density, the Interplanetary Magnetic Field, Bt, and observed wind speeds. The resultant geomagnetic activity was an Active (Kp 4) interval, however, a slight but diminishing chance remains of a G1/Minor Geomagnetic storm interval in the coming hours.
Solar winds were indicative of a slow regime, with slow-ambient speeds and average to below average density. The CME influence has seen wind speeds increase to slightly elevated levels around 420 km/s. Speeds are expected to gradually ease through Day 2 (05 Sep) returning towards background levels. Enlil has incorrectly modelled HSS influence of around 600 km/s, and as such cannot be used for guidance during the forecast period. Two coronal holes may enhance the solar wind during Days 3-4 (06-07 Sep), CH67/- and CH65/+. The HSS associated with the negative coronal hole may could weakly connect with Earth on Day 3 (06 Sep) and the HSS associated with the positive CH65 may connect during Day 4 with speeds of 450-500 km/s. This is somewhat supported by the MOSWOC persistence model (SWPM), although the position of the coronal hole differs to last rotation.
Geomagnetic activity is expected to be initially Unsettled to Active (Kp 3-4), perhaps reaching G1/Minor Geomagnetic Storm intervals (Kp 5) on Day 1. Otherwise, activity is forecast to be Quiet to Unsettled (Kp 1-3), perhaps peaking at Active (Kp 4) on Day 4 should connection to the HSS from CH65/+ occur.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No further CME arrivals are expected.

Figure 2: MOSWOC Enlil showing wind speeds considered too high.

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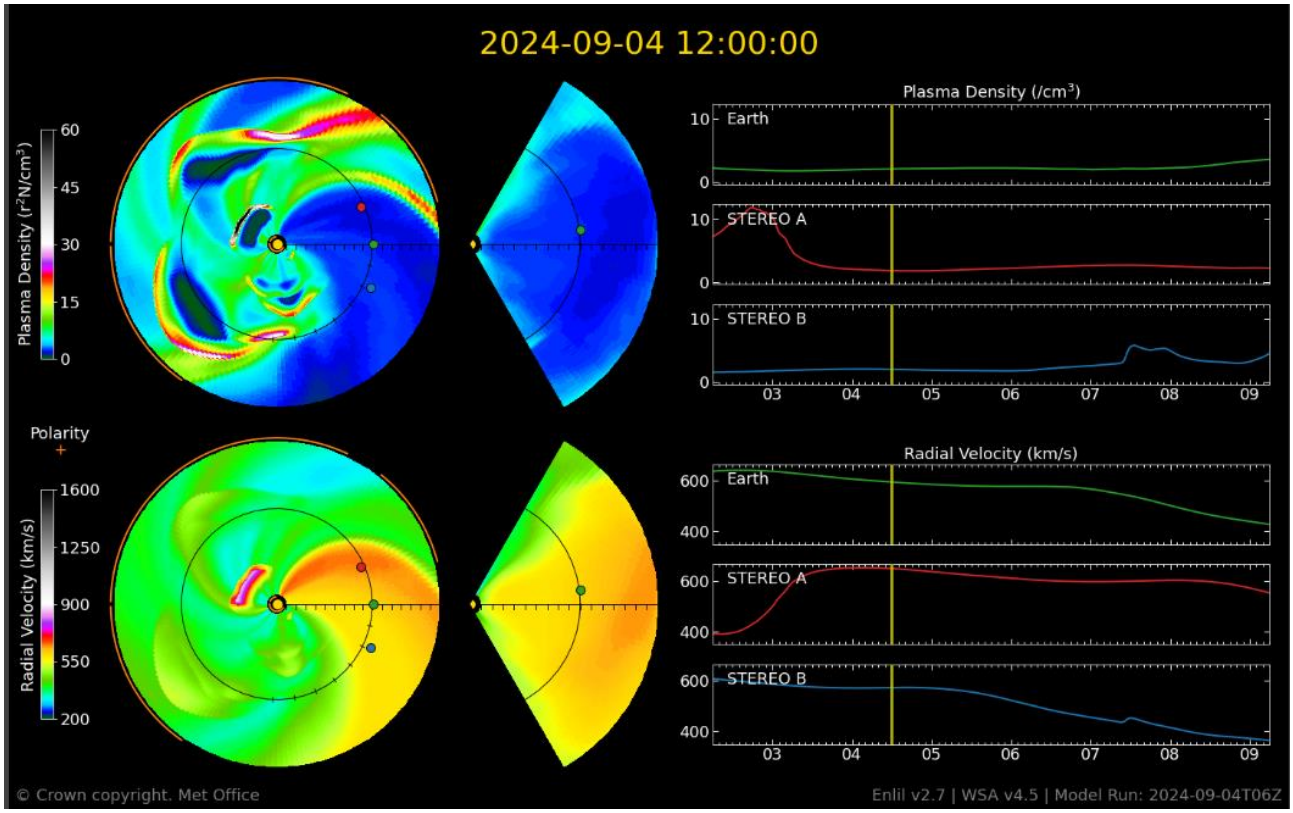
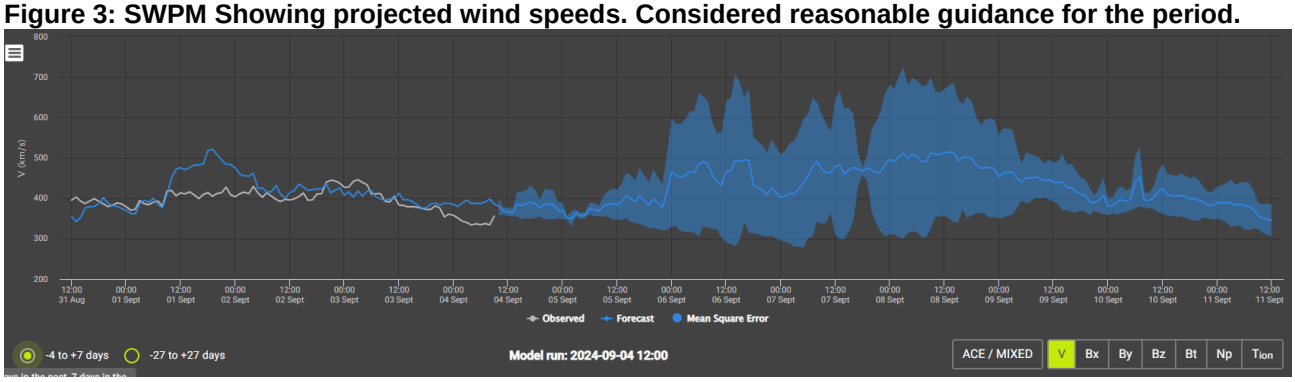


Figure 3: SWPM Showing projected wind speeds. Considered reasonable guidance for the period.



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Radio Blackouts - X-Ray Flares:

There are currently twelve sunspot regions on the visible disc, five of which are unnumbered. AR3807 (Fki/Beta-Gamma-Delta), in the southwest, remains the largest region by area, with a large lead and trail spot and an area of mature penumbra in the central portion which encompasses a delta configuration. This region has seen the proliferation and fading of some small intermediate spots through 04 Sep. AR3806 (Eai/Beta-Gamma-Delta) is one of the more complex regions, with the central portion consolidating further during Day 1 (04 Sep). This group continues to display at least one delta configuration in its central portion.

AR3811 (Dhci/Beta) in the southeast has now lost its delta configuration. AR3813 (Ekc/Beta-Gamma), also in the southeast remains relatively stable in configuration and complexity. The region is still showing significant looping in SDO imagery and may be connected to the unnumbered region that has rotated across the southeast limb, contributing to the overall complexity observed on AIA-0171 and AIA-0094 imagery.

All other regions are comparatively small, simple and stable, although AR3803 has almost faded to a faint pore.

Activity has declined slightly over the past 12 hours to Low levels. However, further M-class flares are expected, with a chance of isolated X-class flares. Whilst AR3807 is expected to rotate off the disc early on Day 3 (06 Sep), the flare risk from this region will remain for around a further 24 hours. Brightness close to the eastern limb suggests that new or returning regions may rotate onto the disc during the forecast period, with the chance of a larger feature rotating across the eastern limb during Day 4 (07 Sep).

A flat trend for flare probabilities is largely maintained throughout, but with probabilities being lowered slightly Days 3-4 (06-07 Sep) due to a combination of departing AR3807 and reduced confidence in the behaviour of spots on the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	70	70
Very Active	R3 to R5 X Class	No	25	25	20	20

Figure 4: GOES18 and GOES16 X-Ray trace over past 24hours

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Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18, is above background levels in response to the large eruption and associated M5.5 flare off the southeast limb during the UTC afternoon of 01 Sep. However, the upward trend appears to be levelling off and it is considered unlikely to reach the S1/Minor Radiation Storm threshold at this time, in the absence of further notable flares.

There are several regions on the disc which could give an increase in proton flux should they produce larger flares, including AR3807 and AR3806 in the western hemisphere. However, neither of these regions has produced flare activity of significance in recent days. Ordinarily, AR3813 would be considered a low risk of exceeding S1 from its current location in the southeast quadrant, but given it has already produced a proton response at Earth from closer to the east limb, this region will pose an increasing risk of proton flux increases as it rotates westward.

Overall, there is a chance of reaching the S1 threshold in the coming days, should there be any larger flares from any of the aforementioned regions.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	25	25	25
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES18 Proton trace over past 24 hours

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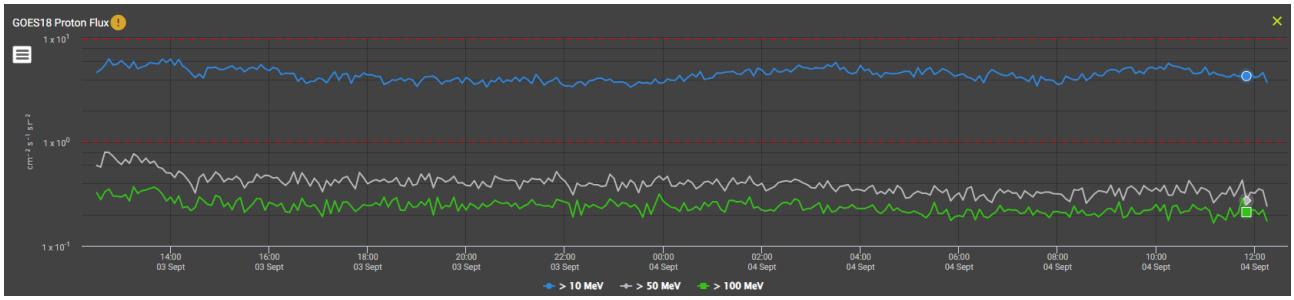


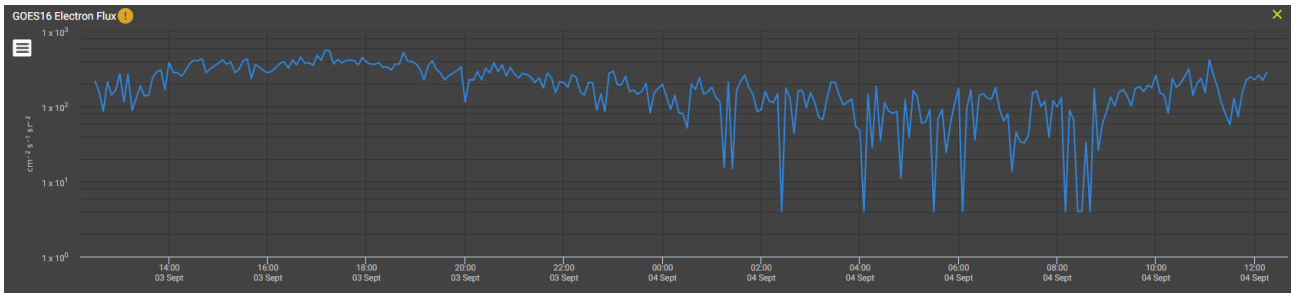
High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 is at background to moderate levels with a minor increase in flux at the diurnal maxima. Following the presumed arrival of some CME shock at Earth on Day 1 (04 Sep), a sharp drop in electron flux to background levels may occur in the short term. Depending on the level of geomagnetic response to this feature, it may then drive an increase in electron flux later in the period. Confidence is low.

Overall, the 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold for much of this period, perhaps with a rising trend much later if we do see CME influence with a geomagnetic response. Therefore, there is a slight chance of exceeding the Active threshold by the end of the period. MOSWOC REFM is showing the most likely forecast, below Active, but will not be taking into account any CME arrival.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: GOES16 Electron Flux and REFM Fluence



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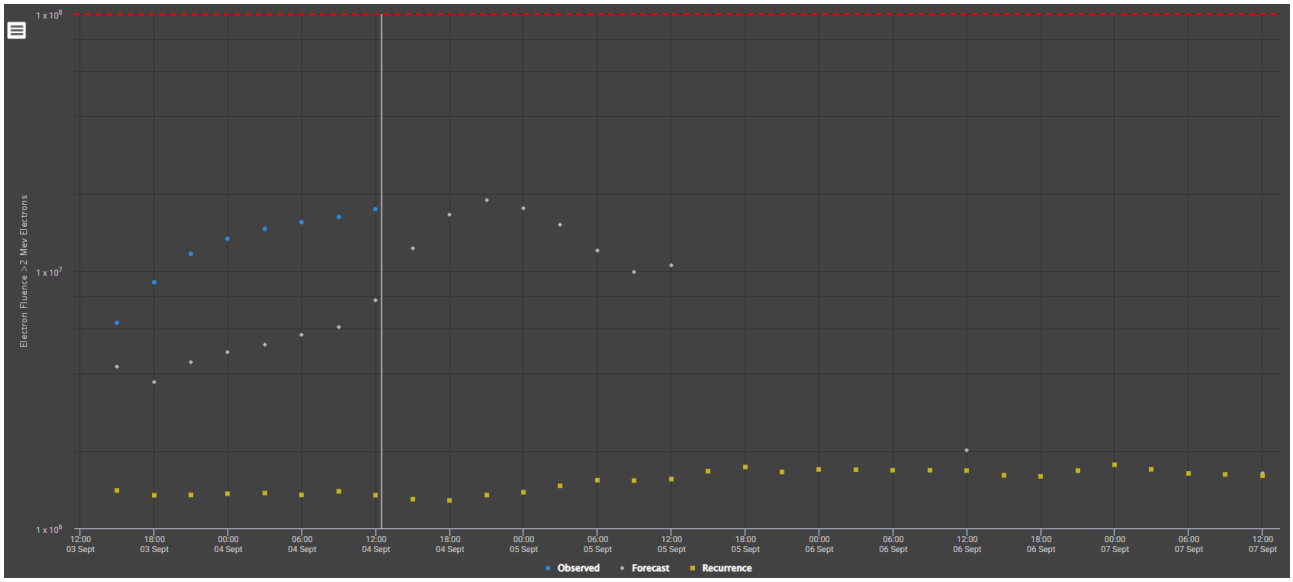

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